favorable for the growth and maturing of crops in the eastern portion. Drought prevailed in the western portion, seriously affecting late corn, potatoes, and pastures, and retarding fall plowing and seeding. Tobacco was cut and housed under favorable weather conditions.—*R. F. Young.*

Washington.—The month was exceedingly favorable for the harvesting of crops and all were secured in good condition. It was too dry for pastures and late vegetables during the first half of the month. Copious showers on the 18th and 19th and general rains from the 24th to the 27th, inclusive, broke the drought, revived pastures, and put the soil in good condition for fall seeding and plowing.—*G. N. Salisbury.*

West Virginia.—September was rather a cool month, and the dry weather was unfavorable for crops. During the last week fairly good showers fell, which were very beneficial in softening the soil, furnishing a water supply, and freshening pastures; late corn was considerably improved by the warm, showery weather, and will make about a half crop; fall plowing was in full progress and buckwheat was being thrashed with a fairly good yield; cabbages, turnips, and late Irish potatoes will make about half crops, and stock was in fairly good condition.—*E. C. Vose.*

Wisconsin.—The first killing frosts of the season occurred generally throughout the State on the 12th and 13th, except for a few favored localities in the southern counties and a narrow strip bordering on the lake. Corn had generally not reached maturity, and the damage was very great. There will be very little hard corn in the State. The late potatoes were also injured by the frosts. The apple crop made surprising improvement during the months of August and September, and a large crop of excellent quality is being harvested. The cranberry crop was injured to a considerable extent by the frost. Damage to the cultivated marshes where there was sufficient water for flooding was not great, but wild bogs suffered severely.—*W. M. Wilson.*

Wyoming.—The month was a cool one, but much fine, pleasant weather prevailed. The first half was very dry, practically no rain falling, but during the latter half unusually heavy rains fell all over the State and were of much value to the stock interests. Farming operations progressed favorably. Grain cutting and thrashing made good progress during first half of month with yield below average. Native hay and alfalfa all in, with average crop for whole State, but large shortages in sections, inducing some early and heavy shipments of cattle. Stock as a rule in good condition. A general frost on 12th did little damage as most crops were gathered. Ranges revived somewhat and streams flushed as result of heavy rains.—*Charles E. Ashcraft, Jr.*

SPECIAL CONTRIBUTIONS.

THE RAINFALL IN THE CITY OF MADRAS AND THE FREQUENCY OF SUN SPOTS.

By M. B. SUBHA RAO, First Assistant, Observatory, Madras, India.

The high temperatures that prevailed in Madras during 1900 and the scarcity of rain both in 1899 and 1900, made me think that these high temperatures might possibly be connected with the paucity of rain. With the object of investigating the subject, I began to hunt up the records at hand and was led to believe that the period 1899 and 1900 resembled the period 1867–68 in many respects. With the little experience I had in meteorological work, as well as with records at hand to fall back on, I began at the middle of 1900 to write short notes predicting the condition of weather at Madras for a local biweekly paper. Emboldened with the success of my prediction I thought of making a thorough investigation of the matter.

Just then the question of the relation of Indian famines and the sun spots was being discussed in the scientific world. I thought then I had better have the list of sun-spot frequency with me before I commenced with the work. Early last October, I applied ultimately to Prof. C. Abbe, of Washington, for a copy of the list, and in December last I was kindly favored by him with one from the year 1749 to 1899.[1] But untoward circumstances prevented me from taking up the work in hand till the end of this April, though I had been collecting the material required since 1900.

Temperature and rain.—Generally years during which high temperatures are recorded are dry years, on some occasions the rainfall being much below the average (49.02 inches). But the years 1870, 1872, 1877, 1880, 1883, 1884, 1887, 1896, and 1898 are found to be exceptions to the rule. During these years the rainfall was very heavy. The years 1870, 1873, and 1874 are rather remarkable ones. The rainfalls for these years are among the highest on record, and occurred in the years of the maximum sun-spot frequency. If the high temperatures are dependent on a low frequency of sun spots, or both of them are caused by something unknown emanating from the sun, these years are a strange exception to the rule. It is curious to note, however, that the heaviness of rain during these exceptional years is caused by the northeast monsoon, which lasts in Madras generally from the middle of October to the middle of December. On the other hand, the years in which low temperatures are recorded are not exclusively years of heavy rain. During 1864, 1865, 1885, and 1899, though the highest temperatures recorded are much below 105° F., the rainfall is also much below the average.

These apparent exceptions can not be satisfactorily explained. If, perhaps, the whole of the east coast meteorological phenomena are taken into consideration the anomaly might probably disappear, or could, with satisfaction, be explained as due to some local cause or other.

Rain and sun spots.—From Tables 1 and 5 it is very clear that the minimum rain occurs almost exactly on the year of minimum frequency of sun spots, the difference being only a year in a few cases.

TABLE 1.

Period.	Years in the period.	Years of minimum sun spots.	Years of minimum rain.
1811–1823	12	1825	1823
1823–1833	10	1833	1832
1833–1843	10	1843	1842
1843–1856	13	1855	1855
1856–1867	12	1867	1867
1867–1878	11	1878	1876
1878–1889	11	1879	1880
1889–1900*	12	1900	1900

*In 1901 the minimum frequency occurs.

TABLE 2.

Period.	Years in the period.	Years of maximum sun spots.	Years of maximum rain.
1811–1823	12	1816	1815
1823–1833	10	1830	1827
1833–1843	10	1837	1839
1843–1856	13	1848	1847
1856–1867	12	1860	1859
1867–1878	11	1870	1870
1878–1889	11	1883–84	1883
1889–1900	12	1893	1896

From Tables 2 and 5 it is to be seen that the maximum rainfall also takes place when we have the maximum frequency of sun spots. But in this case the difference is sometimes two to three years during one or two periods. It is, however, probable that this discrepancy can be avoided or be satisfactorily explained by taking the mean precipitation of the whole of the east coast, say from 8° to 20° latitude. The problem is worth trying.

Table 3 gives the mean precipitation, both when the sun-spot curve is in ascendance and descendance.

It is generally observed that the fall of rain is greater during the rise than when the curve is descending.

[1] The copy here referred to as communicated to Mr. Subha Rao in December, 1901, was practically the same as that which was printed in the MONTHLY WEATHER REVIEW for November, 1901, pp. 505–506. The thorough and important revision of "Wolf's relative numbers for sun spots," published in the MONTHLY WEATHER REVIEW for April, 1902, and elsewhere by Prof. A. Wolfer, of course replaces all the earlier publications on this subject, but the introduction of these numbers into the present memoir would not materially change the conclusions of its distinguished author.

TABLE 3.

Period.	Condition.	Rainfall.	Period.	Condition.	Rainfall.
		Inches.			*Inches.*
1823-1830	Rise.	52.3	1830-1833	Fall.	33.3
1833-1837	Rise.	43.6	1837-1843	Fall.	51.4
1843-1868	Rise.	73.7	1848-1856	Fall.	46.5
1858-1866	Rise.	46.0	1860-1867	Fall.	42.1
1867-1870	Rise.	49.3	1870-1878	Fall.	49.8
1878-1884	Rise.	58.3	1884-1889	Fall.	53.3
1889-1893	Rise.	36.1	1893-1900	Fall.	48.6

There is another fact to be noticed from the data given in Table 5. A periodicity of eleven to thirteen years is observed in the occurrence of both the rain and the sun-spot minima. From these periods a cycle of thirty-three to thirty-five years may be deduced and partly because of this fact I thought, as I have said before, that the years 1867 and 1868 closely resembled the years 1899 and 1900.

In Table 4 the highest average rain in each period for three years is compared with the highest frequency of sun spots and the reader is left to deduce the inference himself.

TABLE 4.

Period.	Highest average rain.	Years.	Highest average sun spots.	Years.
1811-1823	60.32	1816-18	41.1	1815-17
1823-1833	68.48	1825-27	66.8	1828-30
1833-1843	51.55	1837-39	121.0	1836-38
1843-1856	71.85	1846-48	106.2	1847-49
1856-1867	46.75	1864-66	81.6	1859-61
1867-1878	68.04	1870-72	114.0	1870-72
1878-1889	63.19	1882-84	62.3	1882-84
1889-1900	54.61	1894-96	78.9	1892-94

As to whether the numerical frequency of sun spots has any ratio to the measured amount of precipitation is altogether beyond determination for many reasons, especially when the statistics of only one single station are taken into consideration.

TABLE 5.

Year.	Rain.	Frequency of sun spots.	Year.	Rain.	Frequency of sun spots.	Year.	Rain.	Frequency of sun spots.	Year.	Rain.	Frequency of sun spots.
1813	45.11	12.8	1835	41.47	56.9	1857	52.95	22.8	1879	54.25	6.0
1814	32.41	14.4	1836	44.76	121.8	1858	48.50	54.8	1880	61.80	32.3
1815	56.00	35.4	1837	49.26	138.2	1859	55.14	93.8	1881	44.04	54.3
1816	41.16	46.4	1838	52.33	103.1	1860	27.64	95.7	1882	50.20	59.6
1817	63.56	41.5	1839	53.07	85.8	1861	37.19	77.2	1883	60.54	63.7
1818	76.25	30.0	1840	58.65	63.2	1862	38.18	59.1	1884	78.92	63.5
1819	36.33	24.2	1841	58.19	36.8	1863	54.61	44.0	1885	47.88	52.2
1820	70.01	15.0	1842	36.48	24.2	1864	47.23	46.9	1886	47.78	25.4
1821	47.13	6.1	1843	50.28	10.7	1865	41.64	30.5	1887	70.24	13.1
1822	59.61	4.0	1844	65.36	15.0	1866	51.39	16.3	1888	62.48	6.8
1823	26.62	1.8	1845	37.65	40.1	1867	24.37	7.3	1889	43.39	6.3
1824	33.72	8.0	1846	79.81	61.5	1868	41.43	37.3	1890	27.99	7.1
1825	56.05	15.6	1847	80.99	98.4	1869	32.31	73.9	1891	30.46	35.6
1826	60.73	36.0	1848	54.76	124.3	1870	74.10	139.1	1892	42.04	73.8
1827	88.66	49.4	1849	39.81	95.9	1871	56.35	111.2	1893	43.98	84.9
1828	37.89	62.5	1850	36.88	66.5	1872	73.67	101.7	1894	47.78	78.0
1829	36.87	67.3	1851	64.32	64.5	1873	51.83	66.3	1895	47.37	64.0
1830	32.43	70.7	1852	72.69	54.2	1874	62.90	44.6	1896	68.68	41.8
1831	44.35	47.8	1853	35.82	39.0	1875	37.12	17.1	1897	38.47	26.2
1832	18.45	27.5	1854	43.20	20.6	1876	21.60	11.3	1898	68.14	26.7
1833	37.11	8.5	1855	32.32	6.7	1877	66.20	12.3	1899	41.00	12.1
1834	39.00	13.2	1856	46.99	4.3	1878	28.65	3.4	1900	28.93	9.5

Before closing the subject I shall have to say something about the extraordinary weather conditions in Madras during 1900, as the conclusions that may be arrived at have a bearing on the subject at issue. Fig. 1 gives the mean maximum temperature and the wind direction for 1900 as compared with the normal. It at once strikes the observer that the wind direction curve is abnormal, being more westerly from June to September. Following it, the temperature curve reads higher for the same period, the difference in August being most marked, being nearly 5° F. higher. The rainfall for the whole year was only 28.93 inches and only 14 inches fell during the northeast monsoon for a normal of more than double the quantity. Naturally the barometer reading for the period was lower than usual. One of the consequences of this was that during the prevalence of a high temperature on the east coast the rainfall on the west coast in some localities, i. e., between Karwar and Goa, was abnormally high.

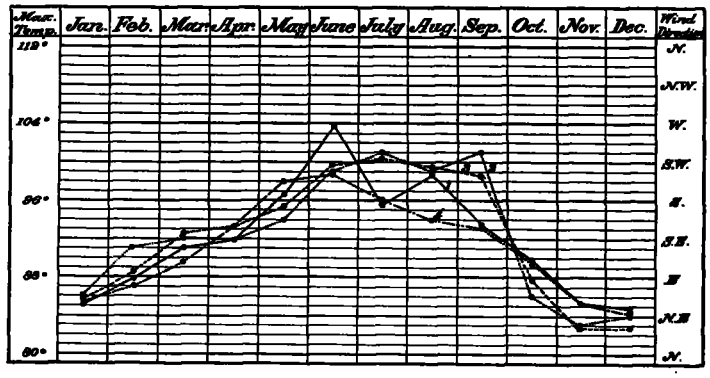

FIG. 1.—Mean maximum temperature and wind direction for 1900.

TABLE 6.

Years of maximum temperature above 105° F.	Highest Temperature.	Date.	Total rain.	Remarks.
1841	106.4	May 8	58.19	
1845	105.2	May 22	37.65	
1847	105.2	April 26	80.99	
1848	106.2	June 21	54.76	
1849	108.3	June 9	39.81	
1853	106.6	May 20	35.82	
1854	110.2	May 28	43.20	
1855	110.6	May 27	32.32	
1860	106.0	May 25	27.64	
1861	106.9	May 12	37.19	
1862	107.1	May 30	38.18	
1866	110.6	May 28	51.39	Extraordinary fall of 21.80 inches in the first week of December.
1867	107.3	June 1	24.37	
1868	106.7	April 30	41.43	
1869	106.4	June 15	32.31	
1870	110.6	May 12	74.10	Extraordinary fall of 6.55 inches in January.
1872	107.5	May 26	73.67	
1873	106.3	June 1	51.83	Heavy rain in February, 6.28 inches.
1875	109.6	May 8	37.12	
1876	109.1	May 15	21.60	
1877	107.3	May 25	66.20	20.60 inches due to a heavy cyclone, May 16-18.
1878	109.5	June 2	28.65	
1879	108.3	April 15	54.25	
1880	107.9	May 30	61.80	
1881	112.9	May 21	44.04	
1882	107.9	May 23	50.20	
1883	107.7	May 24	60.54	
1884	107.5	May 17	78.92	Heavy rain of 33.49 inches in November.
1886	106.5	May 9	47.78	
1887	106.7	May 17	70.24	
1889	108.1	May 21	43.39	
1890	109.0	May 9	27.99	
1891	107.3	June 6	30.46	
1892	108.4	May 22	42.04	
1893	107.6	May 2	43.98	
1894	109.7	June 1	47.78	
1895	109.1	May 18	47.37	
1896	112.4	May 15	68.38	Heavy rain of 32.75 inches in November.
1897	107.1	May 16	38.47	
1898	109.8	May 9	68.14	
1900	109.8	June 3	28.93	

Some are led to think that the effect of sun spots on the quantity of rain on the east coast is opposite to that on the west coast and similarly for other localities in India. So far as I can make out the effect is only indirect, as explained in the above paragraph. In consequence of a comparatively low pressure area on the east coast, the southwest monsoon on the west coast and elsewhere, in some portions depending on the localization of the low pressure area, blows stronger than usual, as in the case of 1900. It is rather difficult for me, with no records to depend on, to say with what low pressure area on the east coast the fall in some particular portion of the west coast would be heavy. Records show that during some years of high temperature in Madras the rainfall

in Mangalore, a station on the west coast almost in the same latitude as Madras, was particularly heavy.

If something like what I have attempted to do in this paper be tried for the whole of the east coast we may get interesting results.

If really the sun has something to do with our monsoons, we may perhaps be better able to predict about their strength, now that a solar physics observatory has recently been established in our midst at Kodaikanal.

A DARK DAY IN WASHINGTON.

By Rev. M. ELLIS, Voluntary Observer, Mason County, Wash., dated October 15, 1902.

Friday, September 12, 1902, was the darkest day that the oldest inhabitant of Hood Canal, in western Washington, ever knew here, owing largely to the smoke from heavy fires in western Washington and western Oregon. At Twana, in Mason County, it appeared as follows: The evening before was somewhat smoky, though not peculiarly so, with a few ashes occasionally falling. About 3 o'clock on the morning of the 12th the whole heavens were a very bright red, according to the statement of a young lady who waked up, as she supposed, about that time, the light being similar in appearance to a certain kind of northern lights only it covered the whole heavens. By 5:30 a. m., when the writer first looked out, it had faded to a dull red. By 7 a. m. the reddish appearance had disappeared, it having turned to a gray color. At 9 a. m. it was possible to read in the house only by getting near a window, and even then it was quite trying to the eyes. By 11:30 a. m. the dull reddish color appeared all around, soon growing very bright in the north, but by 12:30 p. m. the brightest red was in the south. Between 12 noon and 1 p. m. was the darkest part of the day, it being utterly impossible to read out of doors. After 1 p. m. it began to lighten a little, the chickens, which had gone to roost, began to crow; 1:15 p. m. it was again possible to read out doors; at 2 p. m. there was considerable dull red in the sky, but it then disappeared to be seen no more, the heavens becoming again of grayish color. After 3 p. m. was the brightest part of the day.

There were four noticeable peculiarities about the smoke. One was the reddish color above mentioned, another the fact that the smoke did not seem to make the eyes smart, a third that the smoke did not have even the bluish color that dense smoke generally has, and the fourth that any light seen at a distance of twenty or more yards, whether coming from a lamp or a brush fire, was exceedingly white, in fact, very similar to an electric light, and the blaze from a brush fire rose up very slim and tall.

Mr. W. A. Hunter and wife started for their home on the upper Skokomish, 6 miles west of Twana, from the Canal Logging Company's camp, a mile distant, about noon. The road led through the heavy timber but they found it so dark that although Mr. Hunter tried to get along, he found it impossible to drive a team over the road without a lantern, so one was borrowed, which Mrs. Hunter carried, walking ahead, while Mr. Hunter drove the team behind. It was as dark in that timber, Mr. Hunter said, at noon as the darkest night he had ever seen.

The next day the atmosphere returned to its normal condition, and while it was very smoky, so as to make a person's eyes smart considerably, yet it was light enough to read anywhere in the house. The sun was not visible on the 12th.

The darkness seems to have traveled like a wave northward. At Astoria, Oreg., about seventy-five miles to the south, the darkness began on the 11th, so that it was necessary to have lights at 3 p. m. The sky was of a yellowish green and fog from the ocean was said to have mixed with the smoke. At Olympia, 30 miles southeast of Twana, on the 12th, it was darkest about 10 a. m. At Shelton, 10 miles south of Twana, there was considerable yellow mingled with the reddish appearance. Ten miles west of Twana, in the Olympian Mountains, the red appearance continued all day, though toward evening it was somewhat greenish; the brush fires not only had a tall, slim blaze, but were of a greenish color, as if some kind of a gas were burning. At Brinnon, 30 miles north of Twana, the sun was barely visible as a red ball in the morning, and it was not necessary to use lights in the houses until about 3 p. m., while at Twana they were used all day in most houses.

On the eastern part of Puget Sound, at Tacoma and Seattle, the darkness was very marked, but not so much so as on the western side at the base of the Olympian Mountains.

What caused the reddish appearance has not been satisfactorily explained. Some attributed it to the light from the fires, but this does not seem possible. The writer attributed it to the sun's rays working through the darkness, until he learned that the brightest red was seen about 3 a. m. There certainly seems to have been a very peculiar state of the atmosphere that day, which can only be explained by wiser meteorologists than the writer, but the day will be remembered as one in a lifetime.

INDIAN SUMMER.

A letter from W. M. Wilson, Section Director, Milwaukee, Wis., says:

Referring to your favor of recent date in regard to Indian Summer, I beg to enclose herewith the result of the examination of our records by Mr. J. W. Schaeffer, Observer, Weather Bureau.

After going through the records, Mr. Schaeffer is of the opinion that the conditions which are popularly regarded as belonging to Indian Summer obtain quite as frequently in other seasons as during the autumn months.

If you can suggest some better method of tabulating the data or desire a more complete statement I will be glad to have it done.

These periods relate to the seasons ordinarily designated in meteorologies as the mild, dry period, characterized by a hazy and smoky condition of the atmosphere, and occurring at the ending of October and the beginning of November.

The records at this office show that these periods do not occur with any regularity in the successive seasons, and in some years do not occur at all.

1872, Indian Summer set in apparently on September 30, with a hazy and smoky condition; lowest preceding temperature, 40°, on September 27; continued till October 28; cirrus clouds prevailing; rain, 0.56 inches; winds, from calm to 32 miles, generally, however, light from calm to 12 miles; variable, but mainly northwest; highest barometer, 30.49, on 24th; lowest, 29.44, on October 15; mean temperature, 46.7°; maximum, 75°, on 20th; minimum, 29°, on 11th; killing frost October 10; temperature, 32°; rain, 0.22 on 22d, 0.21 on 6th, and 0.13 on 22d of November. September, mean temperature, 62°; rainfall, 8.72. October, mean temperature, 47°; rainfall, 0.73. November, mean temperature, 30°; rainfall, 1.99.

1873, from October 7 to 25 hazy and smoky condition; lowest preceding temperature, 36°, on 6th; cirrus and upper cumulus clouds prevailing; rain, 0.06 on 16th, 0.72 on 17th, 0.01 on 21st, and 0.01 on 22d; winds, from calm to 10 miles, mainly southerly and southwest; highest barometer, 30.48, on 25th; lowest, 29.53, on 21st; minimum temperature, 26°, on 23d; maximum, 75°, on 15th; mean, 49°; evidently killing frost occurred on the 22d. Mean temperature for September, 60°; rainfall, 2.89; mean temperature for October, 46°; rainfall, 1.96; mean temperature for November, 30°; rainfall, 1.72.

1874, evidently beginning September 28 and ending October 25. Clear, hazy and smoky weather predominating, but stratus clouds frequently occurring; rain, 0.11 on 5th, 0.07 on 10th; winds, 2 to 26 miles, generally averaging 10 miles, mainly northwest to southwest, few easterly; maximum barometer, 30.56, on 13th; lowest barometer on 1st, 29.54; mean temperature for the period, 54.4°; maximum, 78°, on 20th; minimum, 28°, on 13th; killing frost on the 12th; mean temperature for September, 65°; rainfall, 4.51; mean temperature for October, 50°; rainfall, 1.90; mean temperature for November, 35°; rainfall, 2.69.

1875, from October 18 to 24, haze on all days; lowest preceding temperature, 29°, on September 27; killing frost; no clouds; no rain; winds southwest, from 5 to 20 miles; highest barometer, 30.16, on 18th; lowest on 23d, 29.68; mean temperature, 48.8°; maximum, 78°; minimum, 33°. Here are six days only that can be called Indian Summer, such periods are common to all months of the year. September, mean temperature, 57°; rainfall, 4.31. October, mean temperature, 44°; rainfall, 2.37. November, mean temperature, 31; rainfall, 1.16.

1876, from October 1 to 28, light haze and smoke occurred on six days